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SOME RESULTS OF THE DETROIT-WINDSOR AIR POLLUTION SURVEY

Morris Katz, et al

Robert A. Taft Sanitary Engineering Center
Cincinnati, Ohio

1958

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Morris Katz, Consultant
Department of National Health and Welfare
Ottawa, Canada

and

Jean J. Schueneman, Public Health Engineer
U. S. Department of Health, Education, and Welfare
Public Health Service
Robert A. Taft Sanitary Engineering Center
Cincinnati, Ohio

For presentation at the annual meeting of the Air Pollution Control Association, Philadelphia, Pa., May 26-29, 1958.

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Abstract

The origin of the study, its purposes, and means of accomplishment are described very briefly. The studies conducted and other actions undertaken are outlined. The principal technical findings are discussed in terms of variation of pollution levels with location in the study area, meteorological parameters and time; estimates of total pollutants discharged to the atmosphere; results of the health study; and observations in the vegetation damage survey. Information is given which will be helpful in the planning and conduct of community air pollution surveys with regard to pollution measurements, pollution emission inventories, and meteorological studies. The voluntary vessel smoke control program and the results of it are described briefly. The current status of the project is mentioned.

Details of illustrations in
this document may be better
studied on microfiche.

SOME RESULTS OF THE DETROIT-WINDSOR AIR POLLUTION SURVEY (1)

Morris Katz (2)
Jean J. Schueneman (3)

INTRODUCTION

In 1948, officials of the cities of Detroit and Windsor requested the State Department and the Department of External Affairs, respectively, to assist in solving a problem which apparently could not be solved by the two municipal governments nor the concerned State or Provincial governments. The problem was to control smoke being emitted by ships plying the Detroit River. The United States Department of State and the Canadian Department of External Affairs, under terms of the Boundary Waters Treaty of 1909 between the two countries, simultaneously referred the problem to the International Joint Commission. The Reference requested the Commission to determine whether or not the air over and in the vicinity of Detroit and Windsor was polluted to an extent detrimental to the area and whether or not ships plying the river were contributing to the pollution and what other sources were responsible. If the ships were found to be responsible for detrimental air pollution, the Commission was requested to recommend remedial measures, to indicate what would be the cost of the corrective measures and by whom the costs should be borne.

To obtain information necessary to reply to the reference, the U.S. and Canadian Sections of the International Joint Commission appointed Technical Advisory Boards. These Boards, with great assistance from many agencies and individuals, conducted the investigations. Much of the work reported here was done by others and was made available to the Technical Advisory Boards but specific acknowledgment is not feasible in this report. Proper recognition will be given in the final report of the Technical Advisory Boards which is presently being prepared. Similarly, specific acknowledgment cannot be made here of the contributions made by those who were members of the Technical Advisory Boards at various times during the investigations nor to those who worked for the Boards. Their significant contributions are gratefully acknowledged.

SOURCES OF POLLUTION

The Detroit Metropolitan Area is the third largest manufacturing center in the United States, although it is the fifth largest in population. Its manufacturing employment is exceeded only by New York and Chicago. Approximately 3,250,000 people live in the international metropolitan area. The

(1) For presentation at the annual meeting of the Air Pollution Control Association, Philadelphia, Pennsylvania, May 26-29, 1958.
(2) Consultant, Department of National Health and Welfare, Ottawa, Canada.
(3) Public Health Engineer, U.S. Department of Health, Education, and Welfare, Public Health Service, Robert A. Taft Sanitary Engineering Center, Cincinnati, Ohio.

extensive industrialization, dominated by the automobile and primary metals industries, together with the extensive use of coal and other fuels, use of vehicular fuels, burning of refuse, and a wide assortment of other activities, gives rise to a large atmospheric pollution load.

Generally speaking, annual fuel usage consists of about 13,000,000 tons of coal, 4,300,000 tons of fuel oils, and 3,800,000 tons of natural gas. Daily use of gasoline is about 3,400,000 gallons and of diesel fuel, 42,000 gallons.

An estimated 1,235 tons of refuse per day are burned in municipal incinerators, 1,300 tons in domestic incinerators, and 400 tons in commercial and industrial incinerators.

Blast furnaces and steel mills comprise a significant proportion of the manufacturing activity in the area. About 7,000,000 tons of pig iron and steel are produced each year. There are also about 30 iron and steel foundries producing about 4,300 tons of castings per day. Approximately 100 establishments are engaged in nonferrous founding and secondary metal refining. About 40 percent of all manufacturing employees work in plants producing automobiles, trucks, and busses, and parts for them. The chemical industry comprises some 200 plants and there is some petroleum refining. A host of other industrial activities also contribute to pollution of the atmosphere.

Solvent losses to the atmosphere from use of paints, dry cleaning, plastics molding, gluing, degreasing, etc. constitute a sizable atmospheric pollution load.

Vessels plying the Detroit River contribute to pollution of the atmosphere by emissions of black smoke, fly ash, and gaseous contaminants from the combustion of coal and oil. The proportion of the total pollution emissions in the area attributable to vessel operations is very small. However, the emissions from vessels are concentrated on the river and are particularly objectionable because of the close proximity of residential, recreational, and civic land uses at many points along the river.

An approximate inventory was made of the principal pollution emissions to the atmosphere from all of man's activities in the area, (Table I). Emissions to the atmosphere in the Canadian portion of the area were found to be about 10 percent of those in the United States portion.

ATMOSPHERIC POLLUTION LEVELS

SUSPENDED PARTICULATE POLLUTION

Numerous measurements were made of suspended particulate matter. Some measurement projects involved sampling for extended periods at a few stations, while other projects involved sampling at a large number of stations for a brief period. Most samples were taken over a 24-hour period using high volume air filters.

TABLE I

ESTIMATED PRINCIPAL AIR POLLUTION EMISSIONS IN TONS PER DAY*

Source of pollution	General public				Industry and commerce			
	Solids	Sulfur oxides (as SO_2)	Nitrogen oxides (as NO_2)	Organics(a)	Solids	Sulfur oxides (as SO_2)	Nitrogen oxides (as NO_2)	Organics(a)
Use of gas	—	1	48	25	---	1	26	15
Use of coal	210	283	42	263	193	408	44	276
Use of petroleum	1	126	55	89	2	230	98	158
Automotive fuel use	1	26	111	597	< 1	4	19	99
Gasoline handling	—	—	---	129	—	---	—	21
Refuse burning	18	2	1	162	5	1	1	41
Solvent usage	—	—	---	78	---	---	---	105
Metallurgical industry	XX	XX	XX	XX	743	(b)	NA	NA
Petroleum refining	XX	XX	XX	XX	1	10	NA	150
Total	230	438	257	1,343	945	654	188	865

*Does not include carbon monoxide or carbon dioxide.

(a) Includes gasoline and solvents. (b) Included in "Use of coal."
A dash entry indicates amount is none or probably minor. NA means data were not available.

Large differences in suspended particulate pollution were found at various locations. For example, three-fold differences in median loadings were indicated among samples taken at 31 stations over a six-week period in May and June of 1952 in Detroit. In Windsor, a two-fold difference was measured in a similar time period, (Figure I). Large differences were noted between stations located fairly close together as indicated particularly by measurements made just south of Hamtramck and also just north of River Rouge.

Monthly averages of suspended particulate pollution measurements made daily during 1954 at four locations in Detroit are shown in Figure II. In comparing stations, it is interesting to note the changing relationships from month to month and that the occurrence of maximum and minimum monthly averages for the year is not uniform.

The influence of wind direction on particulate pollution and indications of transboundary flow of pollution are depicted graphically in Figure III. The data were collected over a 30-day period at six pairs of stations located along both sides of the river.

The figures on the map represent the degree of pollution at six pairs of stations. The length of the lines represents the loading at the stations and the orientation of the line indicates the direction from which the wind was blowing toward the station. The sizes of the circles are proportional to median loadings during the entire project. Although the sampling period was of short duration, a quantitative pollution picture was developed which is in general agreement with subjective opinion, based on location of pollution sources and other factors.

SULFUR DIOXIDE POLLUTION

Pollution by sulfur dioxide was measured at various places in the Detroit-Windsor area and in small communities away from the area. Within the study area, long-term averages ranged from 0.09 ppm to less than 0.01 depending on the location of the sampling station. Mean sulfur dioxide concentrations in Detroit areas of relatively high pollution were 0.09 ppm, while in areas of relatively high pollution in Windsor, the long-term average was 0.04 ppm. Large seasonal variations occur, with monthly averages in the winter two to four times those in the summer. For example, at one station in Detroit, the monthly average in January 1954 was 0.18 ppm and in June of that year, it was 0.05. Average concentrations of sulfur dioxide over long periods in industrial areas of Windsor were five to seven times those measured in the small community of Harrow, Canada, 15 miles from the Detroit River. As indicated by the Thomas Autometer, concentrations in the 0 to 0.05 ppm range are most common and those over 0.15 ppm are rare, (Table II).

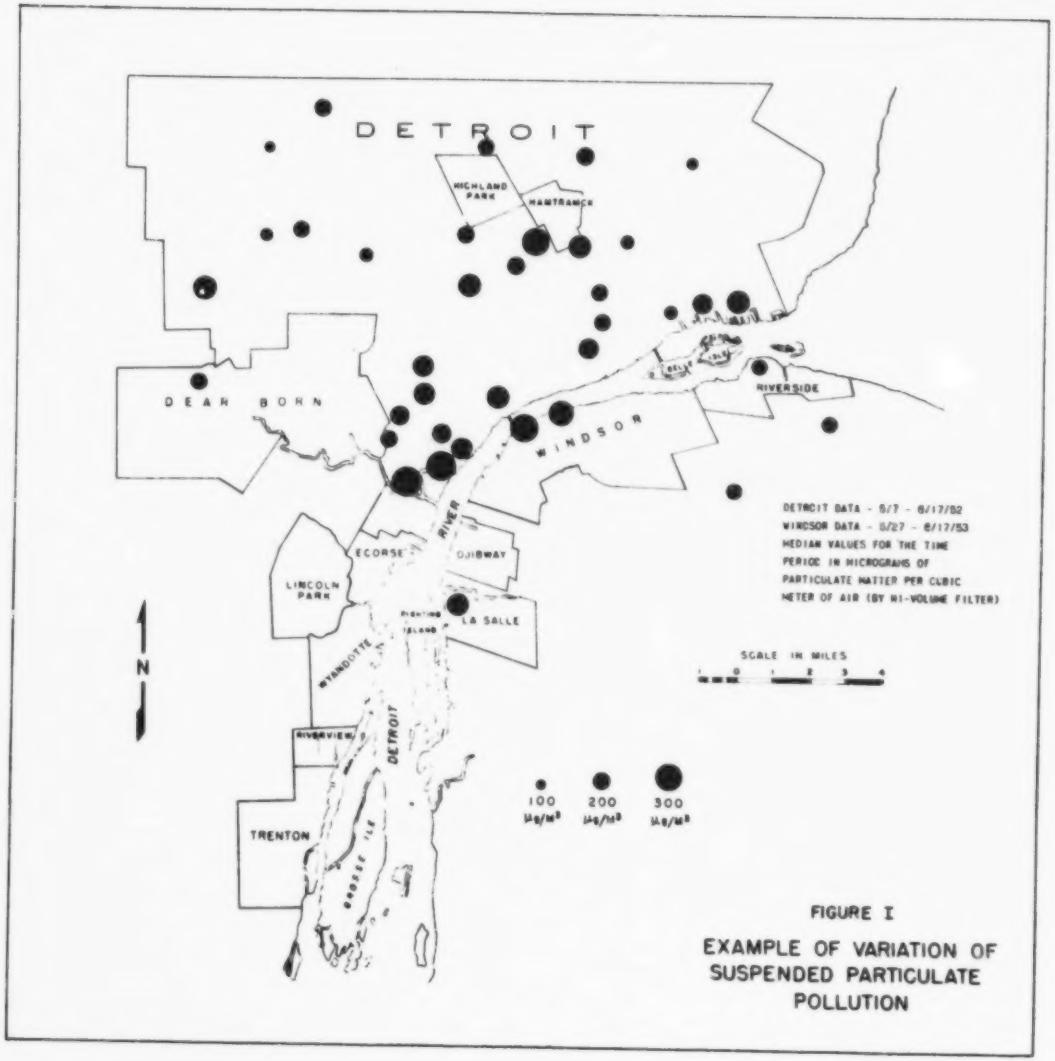

FIGURE I

EXAMPLE OF VARIATION OF SUSPENDED PARTICULATE POLLUTION

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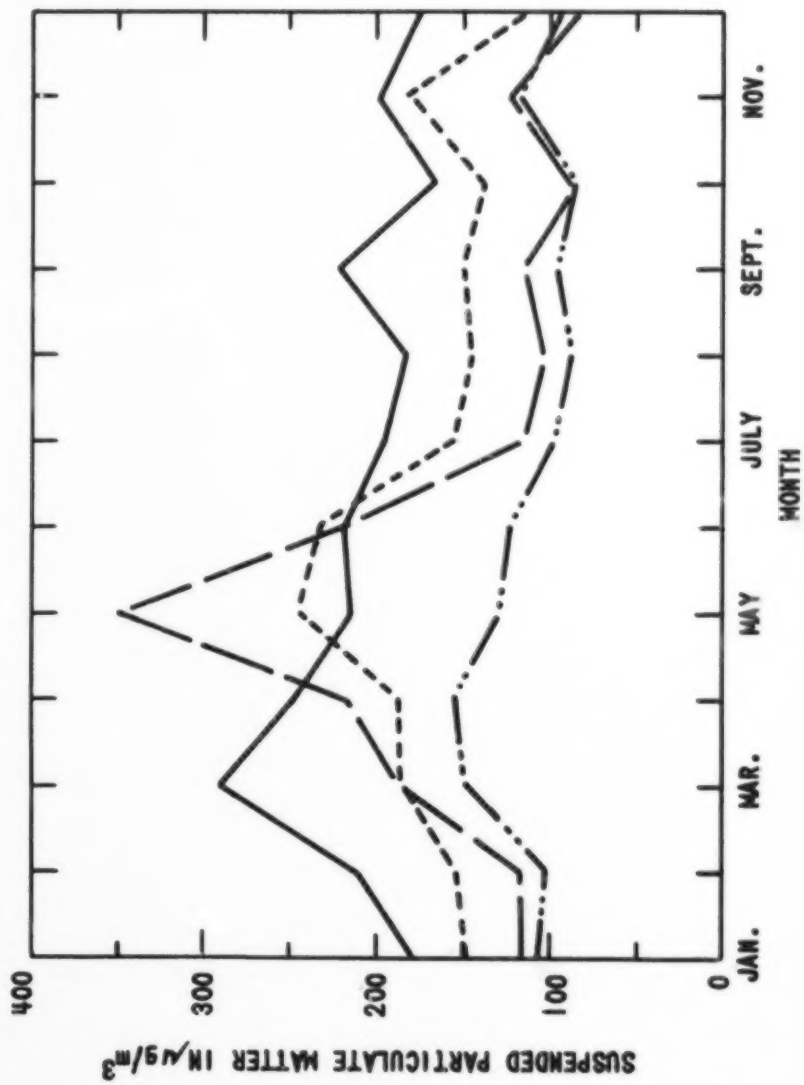

SUSPENDED PARTICULATE POLLUTION AT FOUR
STATIONS IN DETROIT - 1964
(MONTHLY AVERAGES OF 24 HOUR WEEKDAY
AND 72 HOUR WEEK END SAMPLES)

FIGURE 11

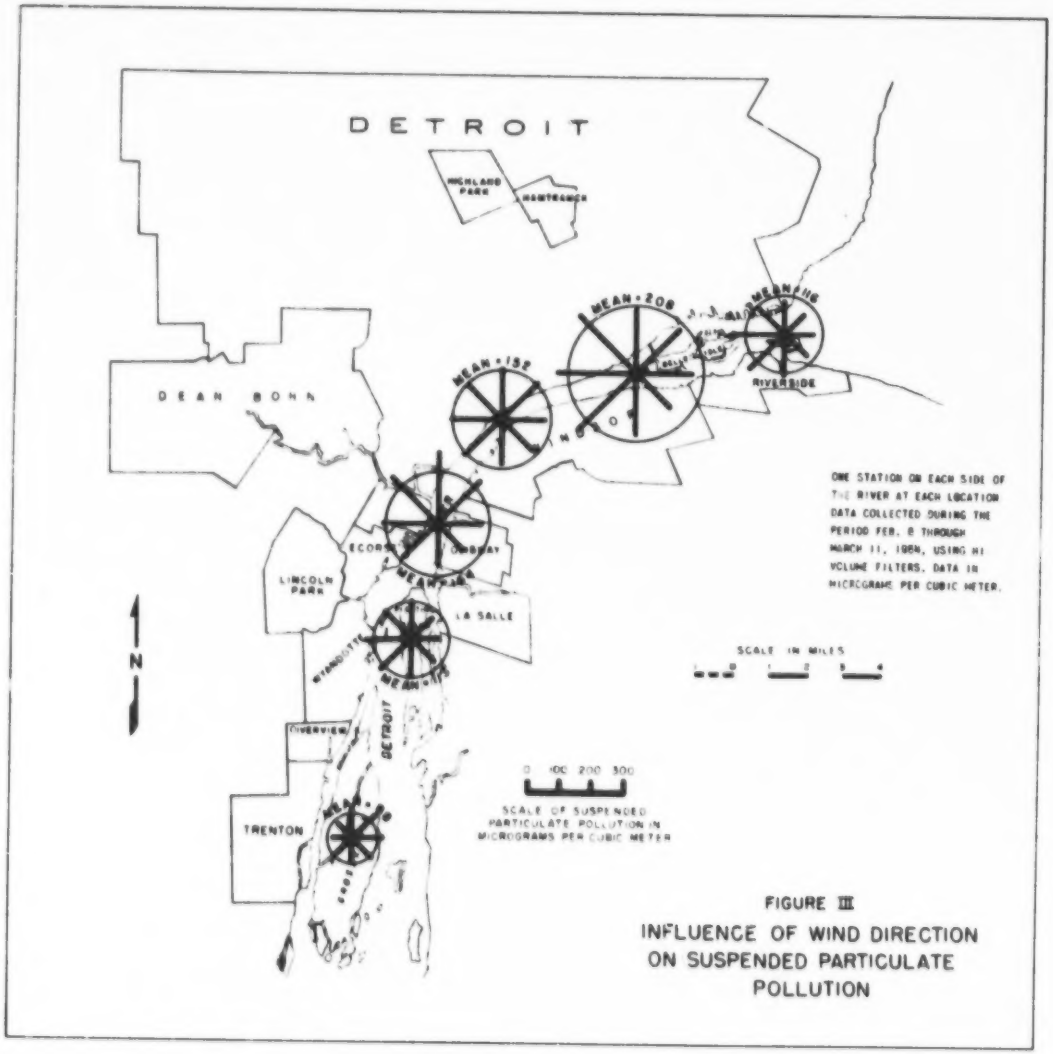
DETROIT
HIGHLAND PARK
HAMTRAMCK
DEAN BOHN
LINCOLN PARK
LA SALLE
RIVERVIEW
TRENTON
DETROIT
MEAN • 208
MEAN • 132
MEAN • 128
MEAN • 118
MEAN • 118
RIVERSIDE
N
ONE STATION ON EACH SIDE OF THE RIVER AT EACH LOCATION DATA COLLECTED DURING THE PERIOD FEB. 8 THROUGH MARCH 11, 1964, USING HI VOLUME FILTERS. DATA IN MICROGRAMS PER CUBIC METER.
SCALE IN MILES
0 100 200 300
SCALE OF SUSPENDED PARTICULATE POLLUTION IN MICROGRAMS PER CUBIC METER

FIGURE III

INFLUENCE OF WIND DIRECTION ON SUSPENDED PARTICULATE POLLUTION

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TABLE II

FREQUENCY DISTRIBUTION OF HALF-HOUR AVERAGE CONCENTRATIONS OF SULFUR DIOXIDE IN 1952*
(Several locations in Detroit combined)

Concentration range in ppm by volume	Number of half-hour periods	Percent of measurements
0.00-0.05	7,038	57
0.06-0.10	3,535	28
0.11-0.15	1,331	11
0.16-0.20	394	3
0.21 & over	160	1

*Data obtained using Thomas Autometer.

SETTLED DUST POLLUTION

Settled dust has been measured in Detroit at 20 stations for many years by the Detroit Bureau of Smoke Inspection and Abatement. The annual average of all stations is in the neighborhood of 65 tons per square mile per month. Values in excess of 200 tons per square mile per month have been found for single months at an individual station. Monthly variation is erratic from year to year but generally varies by a factor of two or three from the cleanest to the dirtiest month in one year. As a rule, dustfall rates are lower in summer than in winter. In the Greater Windsor area, dustfall varies from 66 to 105 tons per square mile per month in heavily polluted areas, to about 37 to 66 in residential areas.

OTHER POLLUTION

Many other pollution measurements were made from time to time at various locations in the Greater Detroit-Windsor area. Some of these are summarized in Tables III and IV.

METEOROLOGICAL STUDIES

A general study was made of the climatology and topography of the area as related to the ability of the atmosphere to disperse pollutants. The topography is generally flat and quite favorable for dispersion of pollution. Climatology is also favorable. There are transitory periods during which conditions favorable

TABLE III

SUMMARY OF AEROSOL POLLUTION MEASUREMENTS, DETROIT AND WINDSOR

Pollutant	General average	Maximum
Total suspended particulate	150 μg/M³	995 μg/M³
Organic suspended particulate	53 μg/M³	105 μg/M³
Chloride (gas & aerosol)	6.1 μg/M³	17.6 μg/M³
Fluoride (gas & aerosol)	.9 μg/M³	3.5 μg/M³
Sulfates	0.5 μg/M³	3.7 μg/M³
Soiling index	1.25-2.35 COHS/ 1000 lin. ft.	13.5 COHS/ 1000 lin. ft.
Particle size	0.94 microns (median)	-
Settled dust	65 tons/sq. mi. /mo.	288 tons/sq. mi. /mo.

TABLE IV

SUMMARY OF GASEOUS POLLUTION MEASUREMENTS, DETROIT AND WINDSOR
(Data in ppm by volume)

Pollutant	General average	Maximum
Sulfur dioxide	0.05(a)	0.44(d)
Oxidant (alkaline KI)(b)	0.005	0.27
Aldehydes (as formaldehyde)(c)	0.20	0.85
Hydrogen sulfide(b)	0.11	0.61
Chlorine(b)	0.10	0.62
Ammonia(b)	0.22	3.07
Nitrogen dioxide(b)	0.05	0.10

(a) Continuous recorder; half-hour average. (b) 10- to 30-min. samples. (c) 1- to 5-hour samples. (d) 6-hour average; continuous recorder.

for accumulation of air contaminants near the ground can develop, principally during night hours in the warmer portion of the year. There is little evidence that such conditions persist for extended periods and the frequency of occurrence is low in relation to that in some other areas.

Records of vertical temperature gradients made twice daily at Toledo and Mt. Clemens were studied to gain information helpful in understanding pollution dispersion in this general area. Among the findings was confirmation that considerable variation in nocturnal inversions occurs over fairly small distances. At the Toledo and Mt. Clemens stations the modal thickness of all inversions of the advection, subsidence, and frontal types combined is about 800 feet, and for nocturnal inversions the thickness is about 400 feet. The median intensity of the former types of inversions is 4.5 degrees F. per 1000 feet; for nocturnal inversion intensity is greater, but a median was not determined.

Instruments for continuously recording temperature were installed on the WJBK television tower, with sensing elements at 20, 300, 600, and 870 feet above ground. Studies using this installation are still being made. Observations so far indicate that pollution levels are quite closely correlated with vertical temperature gradients measured on the tower. It has been noted that an inversion of some sort occurs on about 75 percent of the nights in the summer and fall. Temperatures indicating the existence of an inversion in all layers below 870 feet occurred most frequently in the summer and fall during hours of darkness. Maximum inversion intensities which occur during a month in the 20-to 300-foot layer were found to range from 6.0 degrees F. in December to more than 16 degrees in March and September. The most probable duration of nocturnal inversions is about 14 hours in summer, 15 in winter, and 11 1/2 hours in spring. Evaluation of the usefulness of the data from this installation has not yet been fully explored. As further use is made of these and similar data from other areas, it will be possible to determine whether or not the sizable expenditure needed to establish a facility of this type is justified.

Occurrence of high and low pollution levels on separate days at each station followed a generally similar pattern. The various meteorological and pollution emission factors apparently act as a system throughout the area and are strongly influenced by synoptic weather conditions. A set of synoptic conditions was defined on the basis of which it was possible to determine occurrence of relatively high pollution periods on about three tries out of four. However, a set of synoptic conditions by which times of relatively low pollution could be defined could not be established.

Daylight illumination in downtown Windsor was compared with that in the small town of Harrow. Monthly average illumination in Windsor was found to range between 80 and 95 percent of that in Harrow and averaged 92 percent during the year 1954. Light transmission measurements made in downtown Detroit through the use of a transmissometer ranged from 68 percent in the winter to 79 percent in the summer on the basis of monthly averages.

EFFECTS OF POLLUTION ON HEALTH

MORBIDITY STUDY

An attempt was made to relate the varying degrees of air pollution in the Detroit-Windsor area to the health and well-being of its inhabitants. The project was considered a pilot study in a new field involving control of many factors which could introduce spurious relationships.

Portions of Detroit and Windsor are subject to differing amounts of dustfall, sulfur dioxide, and suspended particulate matter, and on the basis of these conditions, areas of "high" pollution and "low" pollution were selected. From these areas, population groups identical in numbers and in economic and racial characteristics were chosen for study as to present state of health and occurrences of aberrations from their normal status.

Evaluation of health status was made using the Cornell Medical Index, a tool of some value in determining the presence of illness by means of patient questionnaire, although it is of uncertain value in determining the actual disease. To assay current health status, a system of patient interview and patient-kept calendars was used.

The health studies on both sides of the river were integral parts of one study. The Windsor area study was directed by the Department of National Health and Welfare in Ottawa, Canada with the cooperation of the Provincial Department of Health for Ontario. The Detroit area study was done by the Detroit Department of Health.

Environmental data developed during the course of the study indicated that differences in pollution were of much smaller scale than initially believed. In fact, pollution levels in the "low" areas frequently exceeded the basic levels in the "high" areas, although the original premise of a coincident rise in both areas at times of high pollution did exist most of the time. The relatively slight differences in levels of pollution caused questions as to whether differences in health status could result in the areas studied.

An attempt was made to prove two hypotheses: (1) The health status of people living for long periods in areas of high average pollution is adversely affected, in comparison with persons living in other areas; (2) Persons exhibit symptomatic response to peak episodes of pollution (short periods of extreme concentrations). It is important to distinguish between these two hypotheses since they represent two quite different effects of air pollution and may require different techniques of study. Further, the resulting remedial action may well be different should either hypothesis be supported. The second hypothesis was not of major concern, although it was of interest. There is already evidence of human response to peak episodes of pollution both from industrial experience and disasters such as those occurring in Donora, Pennsylvania and the Meuse Valley.

A variety of indexes were used to present the morbidity picture so as to give optimum sensitivity to the data. Frequency distributions were prepared of persons by number of times sickness began, by the duration of sickness, by the incidence of different types of sickness, and in the various age groups. Greatest emphasis was placed on upper respiratory illness in the belief that this type of sickness might be the most sensitive index of effects from temporarily increased levels of pollution. Extensive data analysis failed to reveal statistically significant indications of differences among the populations living under various conditions of atmospheric pollution.

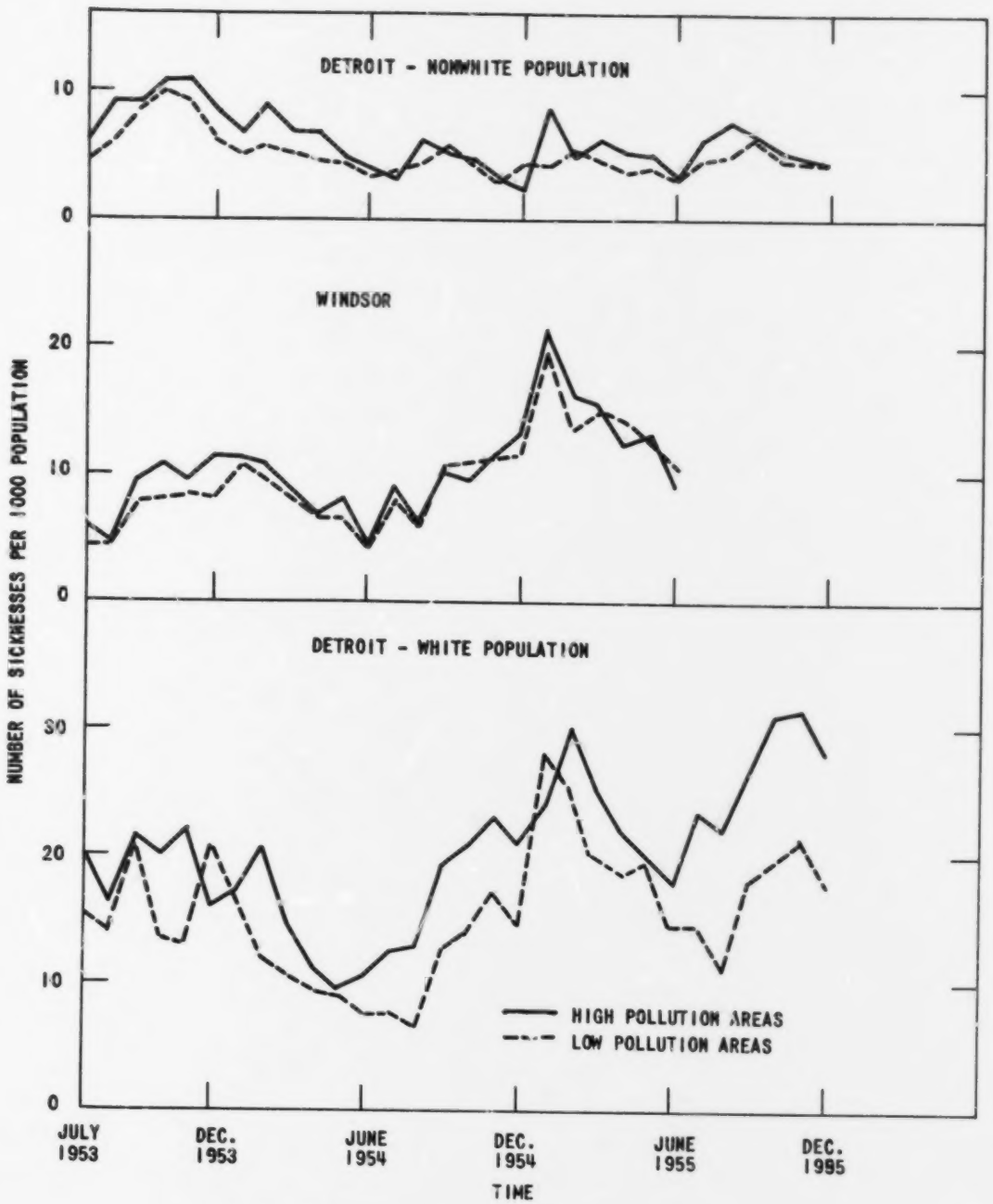
It was observed that the monthly rate of sickness in all areas followed similar chronological patterns, although at differing levels. The two areas populated by nonwhite people in Detroit evidenced this tendency to the least degree. One remarkable finding which developed from the accumulated data was the striking pattern of sickness rates in the two Detroit areas populated by white people. The sickness rates in the high pollution area are generally above those in the low pollution area and both follow a similar pattern, (Figure IV). This relationship fails to appear as clearly when comparing the two nonwhite populated areas in Detroit with each other and the two areas in Windsor with each other. One possible explanation is the fact that pollution level differences between the two white populated areas in Detroit were greater than differences in the other two pairs of areas. However, statistical considerations and questions concerning validity of field data make it improper to attach great significance to this occurrence.

The following conclusions have been reached:

1. When data resulting from the entire survey are considered in all their aspects, the observed differences in pollution levels between the areas were not proven to be associated with corresponding differences in the health status of people living in the area.

2. The possibility that the results are inconclusive rather than negative must be considered. The findings may be due to the fact that the effects are too small with the pollution differentials prevailing in the area to be apparent with the relatively crude health measurements employed. It may be that in any case such effects are too minor to be of practical consequence. A further possibility is that deficiencies in carrying out, or inherent in, the methodology (e.g., enumerator variation, unrepresentativeness of pollution data, overly small observed populations, inaccuracies in sickness information) have obscured any effects present. Finally, a combination of these factors may be operating.

3. This study, as mentioned above, was intended primarily as a pilot project to investigate the potentialities of the household morbidity survey as an instrument for measuring health in relation to pollution. The assessment of methodology is not yet complete, and, to date, the investigation



AVERAGE DAILY RATE OF SICKNESS

Figure IV

clearly emphasizes the need for further consideration of the best approaches to the elucidation of the relationship, if any, between air contamination and the health status and sickness experience of the exposed populations.

RESPIRATORY CANCER MORTALITY

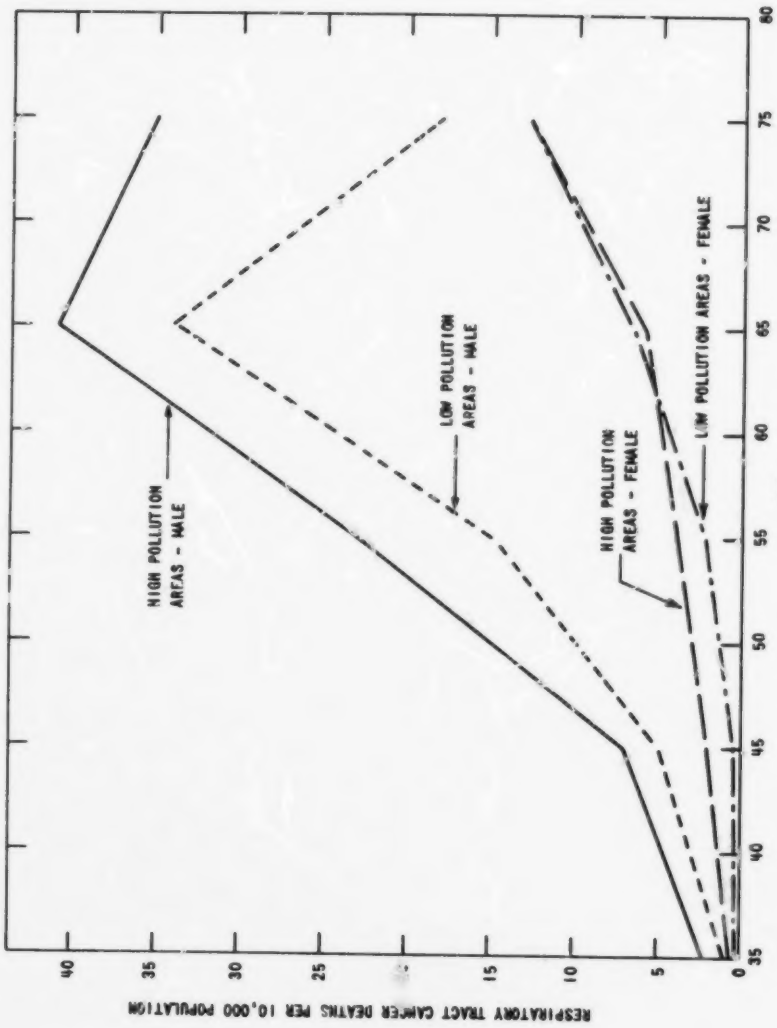
Deaths attributed to cancer of the respiratory tract in Detroit during the period 1946-1949 were tabulated and analyzed. Figure V shows age specific respiratory tract cancer rates in areas of high and low atmospheric pollution. There is a higher rate in males as compared to females and a higher rate in areas of high pollution as contrasted with areas of low pollution. These differences were found to be statistically significant. However, this does not prove that air pollution caused the cancer deaths.

MORTALITY DURING A SMOG EPISODE

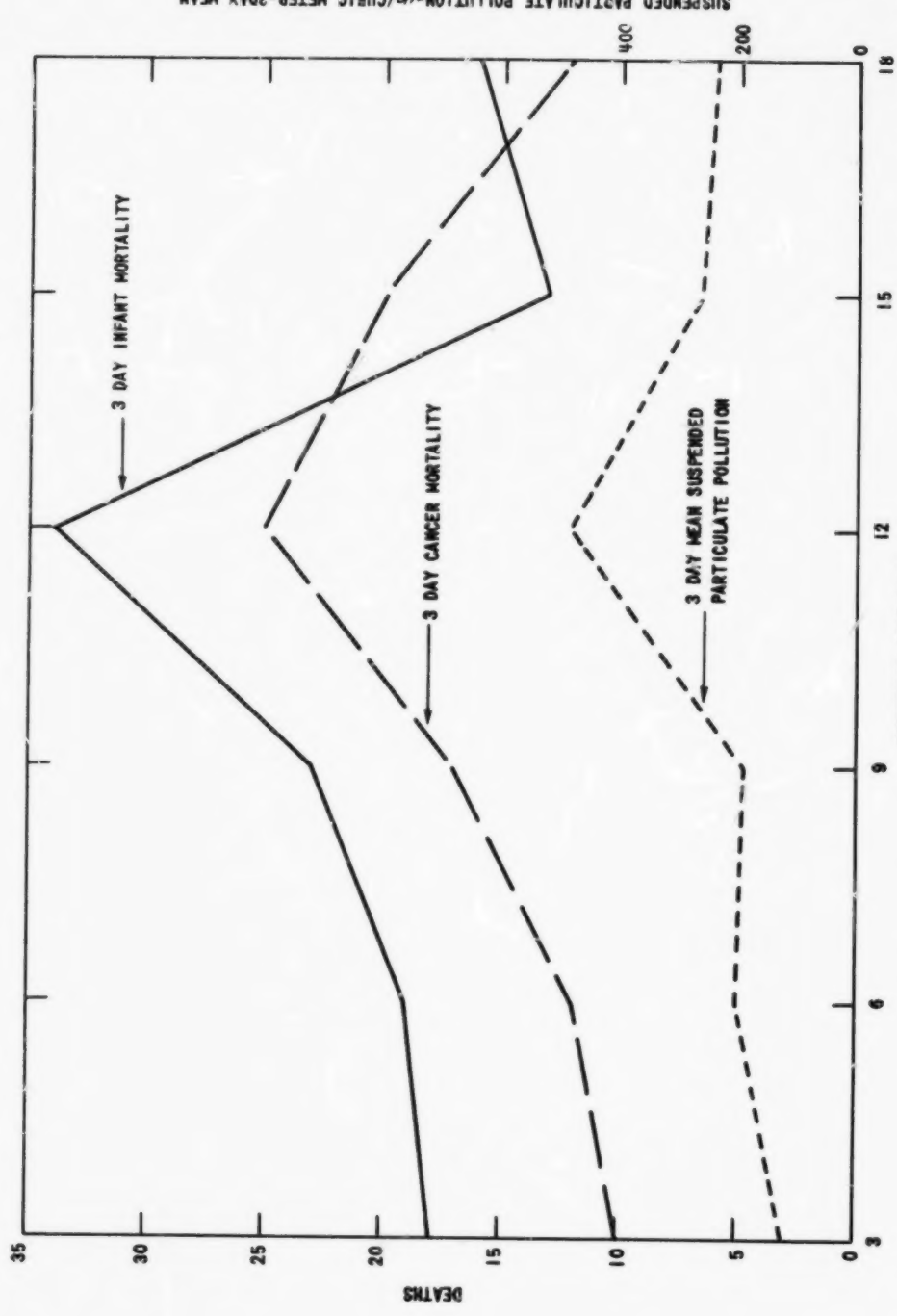
During the early part of September, 1952, a three-day period of atmospheric stagnation occurred. Meteorological conditions were such that pollution levels reached umusually high values. There were many complaints of eye irritation and respiratory discomfort reported by citizens in the Detroit-Windsor area. A study of mortality records in the area revealed a striking rise in infant mortality and in deaths of individuals with malignant disease during the period, (Figure VI). This was a single occurrence and no great significance can be given to the relationship. Because pollution conditions of this intensity occurred only once during the study, further verification could not be obtained. A relationship between mortality in vulnerable groups groups and rises in atmospheric pollution has been demonstrated in other areas. The dramatic rise in mortality in the London smog of 1952 has aroused great interest throughout the world. The fact that a similar phenomenon can be demonstrated, even though not proven, in the Detroit-Windsor area is worthy of note.

EFFECTS OF POLLUTION ON VEGETATION

Injury to vegetation in proximity to a limited number of land-based sources of pollution has been noted on both sides of the International Boundary. A survey team made general observations of vegetation throughout the study area, particularly in the vicinity of probable sources of pollutants, in an attempt to determine the nature and extent of injury. On the Canadian side of the study area, chlorophyll content in conifer leaves and extent of conversion of this pigment to pheophytin were determined. It was concluded that there is no unequivocal indication of an over-all repressive effect on the vegetation of the region due to air pollution. Where symptoms of injury to vegetation presumably attributable to air pollution were found, they were limited generally to a few susceptible species in the immediate vicinity of a large probable source of pollution. Examination of the plants usually suggested that the injury arose from a specific pollution incident or combination of circumstances of relatively



RESPIRATORY TRACT CANCER MORTALITY; DETROIT - WINDSOR, 1940-1949
Figure V



INFANT AND CANCER MORTALITY IN DETROIT - WINDSOR DURING A "SMOG EPISODE"

Figure VI

short duration (a matter of hours perhaps) rather than from a long-term exposure.

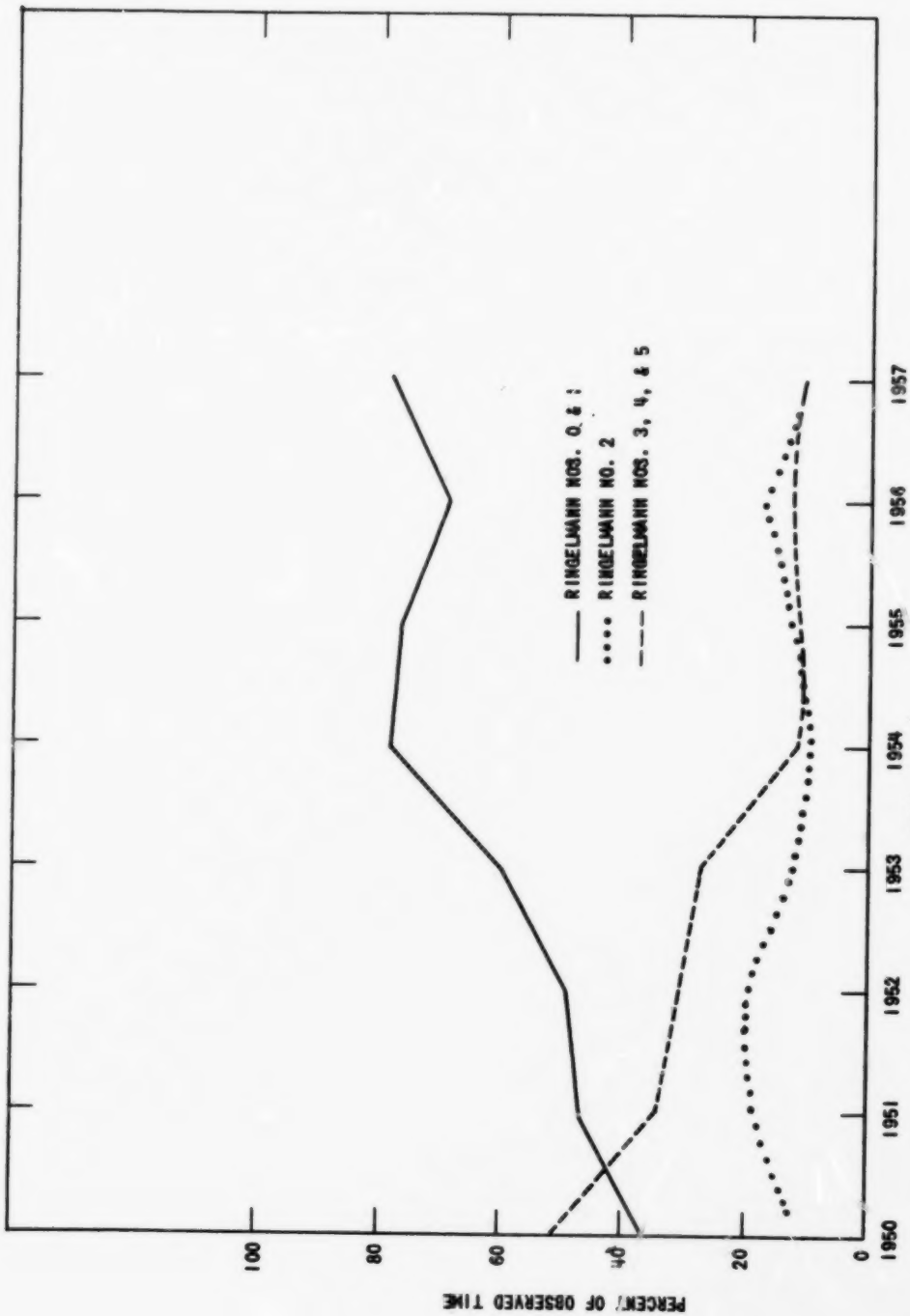
VESSEL SMOKE AND VOLUNTARY CONTROL PROGRAM

The nuisance created by excessive smoke and fly ash emission from vessels on the Detroit River was primarily responsible for reference of the Detroit-Windsor pollution problem to the International Joint Commission. Ringelmann smoke observations made in the 1950 navigation season disclosed that passages of the river by 466 vessels had resulted in the emission of Ringelmann No. 3, 4, or 5 smoke on about 86 percent of all passages and that the duration of such excessive smoke conditions amounted to about 51 percent of the time.

Steady progress was achieved in the abatement of smoke in succeeding years through the combined efforts of the Technical Advisory Board, air pollution control departments of municipalities along the Detroit River, and the Great Lakes Air Pollution Abatement Program formed by the Lake Carriers' Association, Dominion Marine Association, Bituminous Coal Research, Inc., and the Coal Producers Committee for Smoke Abatement. This progress was assisted materially in 1952 and subsequent years through the establishment of "Smoke Emission Objectives" for a voluntary vessel smoke abatement program. The most notable reduction in smoke emissions occurred in the years 1951 through 1954, (Figure VII). The results are based on smoke observations of approximately 500 to 650 vessels in each navigation season since 1950, involving about 2500 to 4500 vessel passages per season or about 15 to 20 percent of all traffic on this international waterway.

The hard core of the vessel smoke problem has been reached within the last few years. The great majority of vessels equipped with automatic firing installations, such as diesel engines, oil-fired furnaces, underfeed and spreader stokers, have shown satisfactory progress in smoke abatement and have little difficulty in meeting the emission requirements of modern air pollution control regulations. However, smoke emission from about 25 percent of the vessels is still excessive. Nearly all the vessels in this unsatisfactory class are powered by hand-fired, coal-burning boilers and require conversion to automatic firing methods or to other fuels before further progress in smoke abatement can be achieved.

About 45 percent of the Canadian Great Lakes fleet are hand-fired, coal-burning vessels. In the United States fleet, this class represents about 37 percent of the vessels. A large proportion of the Canadian hand-fired fleet consists of canal-sized vessels of approximately 1600 to 2400 tons. Such vessels were designed within the limits prescribed for navigation of the St. Lawrence River canals and presently perform a vital service in the forwarding of cargoes carried by the upper lake vessels to the Port of Montreal and other lower St. Lawrence ports. The changing pattern of Great Lakes shipping, with the opening of the improved seaway, may well force some of the canal-sized vessels into retirement or to other uses.



VESSEL SMOKE EMISSIONS - DETROIT RIVER

Figure VII

TRENDS AFFECTING POLLUTION FROM VESSELS

The future growth of vessel traffic on the Great Lakes and on interconnecting waterways such as the Detroit River is linked intimately with the effects of the opening of the St. Lawrence Seaway. The St. Lawrence Seaway power and navigation project, scheduled for completion in 1959, will provide for movement of vessels with a 27-foot draft from the Atlantic Ocean to the lower Great Lakes. The most important change in water transportation resulting from this project may be passage of large bulk freighters of the Great Lakes into the lower St. Lawrence, and vice versa.

Within the last few years there has been a continued increase in the entry into the Great Lakes of foreign vessels engaged in transoceanic trade. This trend will be accelerated with the completion of the St. Lawrence Seaway, but it is believed that the trade of these ocean vessels will be in package freight and high-class merchandise rather than in bulk cargoes. The danger of competition from foreign vessels will be severely restricted by several factors. Modern Canadian and United States Upper Lakes bulk freighters transport cargo at the lowest cost per ton-mile in the world in spite of high construction and operating costs. Furthermore, vessels under a foreign flag or those constructed in a foreign country are restrained by law from engaging in coastwise trade between United States ports. This restriction would, in itself, eliminate competition from foreign vessels in about 88 percent of the total United States traffic on the Great Lakes. Probably the most important possible diversion of trade from United States Great Lakes vessels to foreign vessels is in the future movement of grain. For the most part, ocean-going vessels are powered by modern plants and do not emit excessive black smoke.

A sizable increase in marine transportation is anticipated after the St. Lawrence Seaway is opened. Estimates indicate that Detroit River vessel traffic will be 80 to 110 percent greater in the year 1960 and about 200 to 270 percent larger in the year 1965 as compared with tonnage loads in 1952. These increases in vessel traffic will undoubtedly result in an increase in pollutants discharged to the atmosphere. The need is therefore apparent for conscientious efforts to reduce such emissions to the practical minimum, with particular emphasis on the control of excessive smoke. However, two factors will tend to lessen the pollution load. One is the gradual conversion of hand-fired coal-burning vessels to automatic stoker or oil firing. The other is that nearly all vessels constructed in the last few years have been equipped with either oil-fired boilers or diesel engines and this type of construction is expected to set the pattern for future shipbuilding on the Seaway and Great Lakes system.

CURRENT STATUS OF DETROIT-WINDSOR AIR POLLUTION PROJECT

The Technical Advisory Board has completed its studies under the Air Pollution Reference and a final report on all aspects of the work will be presented to the Commission in the fall of 1958. This report is now nearing completion but it is by no means a detailed account of all the studies conducted over the six-year period. Much of the data will remain in progress reports filed with the International Joint Commission. However, all questions asked in

The Reference will be answered with supporting facts and findings, and recommendations will be submitted for dealing with the problem of vessel smoke on a regulatory basis, backed by appropriate enforcement machinery. The recommendations will also deal with proposed remedial measures and costs of such measures.

It is anticipated that a great deal of information in the final report will be of scientific interest to those concerned with the organization and conduct of surveys of urban and regional air pollution problems. The experience in methodology gained in the pilot health study will, no doubt, facilitate future studies of the effects of air pollution on public health.

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